1342

# IMPACT EVALUATION

# *RHIZINA UNDULATA* FR.:
# DISTRIBUTION AND DAMAGE APPRAISAL
# WESTERN OREGON AND WASHINGTON

Pacific Northwest Region
U.S. Forest Service
Branch of Insect and Disease Control
Portland, Oregon

R06 2952
1342

U. S. Forest Service
Region 6

5200
Portland, Oregon
September 1973

# *RHIZINA UNDULATA* IMPACT EVALUATION

By

Walter G. Thies, Plant Pathologist

## ABSTRACT

During the summer of 1973, a survey was conducted on National Forests in western Oregon and Washington to determine if *Rhizina undulata* Fr. was causing serious losses of seedlings planted on recently burned areas. The survey involved a general search of 144 such units to locate ascocarps of the fungus followed by a systematic examination of the 23 units where ascocarps were found. The mortality attributed to Rhizina root rot averaged 0.04 seedling per acre. There was no significant correlation between the presence of *R. undulata* ascocarps and seedling mortality.

# RHIZINA UNDULATA SURVEY REPORT

by Walter G. Thies

## INTRODUCTION

Rhizina undulata Fr. is reported to cause a root rot of conifer tree seedlings planted on clearcuts soon after slash burning. This disease could be a potential threat to efforts to reforest burned areas in the Pacific Northwest.

As early as 1915,[1] James R. Weir reported that R. undulata caused mortality of seedlings in the Northwest. In recent reports, Paul Morgan and Dr. Charles Driver reported that their surveys conducted in 1970[2] and 1971[3] located 12 widely scattered seedling plantations infected with R. undulata in western Washington. They estimated seedling mortality on eight of the infected sites. Their technique involved locating R. undulata ascocarps, counting the mortality around the ascocarps, and estimating the area infected within the burned sites. They reported one site with seedling mortality of 10 to 25 percent, six sites with seedling mortality of 25 to 50 percent, and one site with seedling mortality of over 50 percent. They did not report that the entire area of each clearcut was surveyed, thus no indication was given of the overall mortality due to R. undulata or the mortality due to any other cause within the sites.

Spores (ascospores) of R. undulata are discharged from mature fruit bodies (ascocarps) from July to September and are washed into the soil by rain. The ascospores remain dormant in the soil until stimulated by high temperatures such as produced by fire. Many spores in the surface layers of the soil are destroyed by the high temperatures of the fires; but others, lying in more protected positions, are stimulated by the heat-shock and germinate. Following spore germination, the mycelium colonizes woody debris and remains to later infect the roots of adjacent conifer seedlings. Infected seedlings develop symptoms similar to those encountered with other root rots. Affected seedlings usually occur in groups, although scattered individuals may be found. The needles discolor and may die 1 to 2 months after infection (Figure 1). The presence of ascocarps is necessary to identify the pathogen.

Ascocarps are produced on duff and mineral soil frequently in protected areas under slightly raised logs, branches, roots, and stumps. The ascocarps appear first in early spring as small, cream-colored buttons and may continue to appear through the growing season until frost. As they expand, they become chestnut to dark brown and irregularly circular with a pale yellow margin (Figure 2). Well-developed ascocarps are of a similar color, 3 to 10 inches in diameter, effused, undulating, and

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[1] Weir, J. R. 1915. Observations on Rhizina inflata. J. Agr. Research 4:93-96.

[2] Morgan, P.D. and C. H. Driver. 1972. Rhizina root rot of Douglas-fir seedlings planted on burned sites in Washington. Plant Dis. Reptr. 56:407-409.

[3] Morgan, P. D. and C. H. Driver. 1973. Rhizina root rot in conifer plantations in western Washington. Plant Dis. Reptr. 57:167-169.

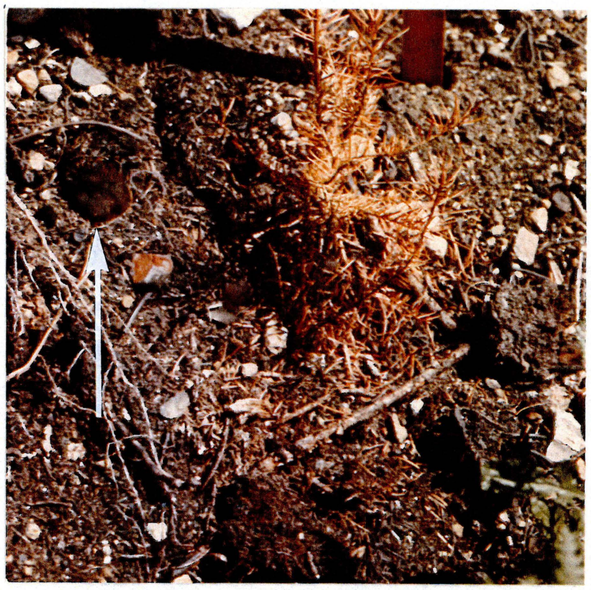

Figure 1.-- Dead Douglas-fir seedling near R. undulata ascocarp. May 1973

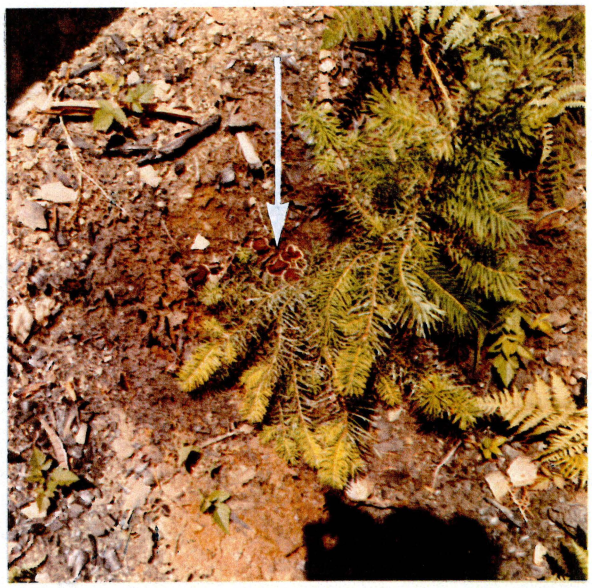

Figure 2.--Apparently healthy Douglas-fir seedling near growing R. undulata ascocarps. May 1973

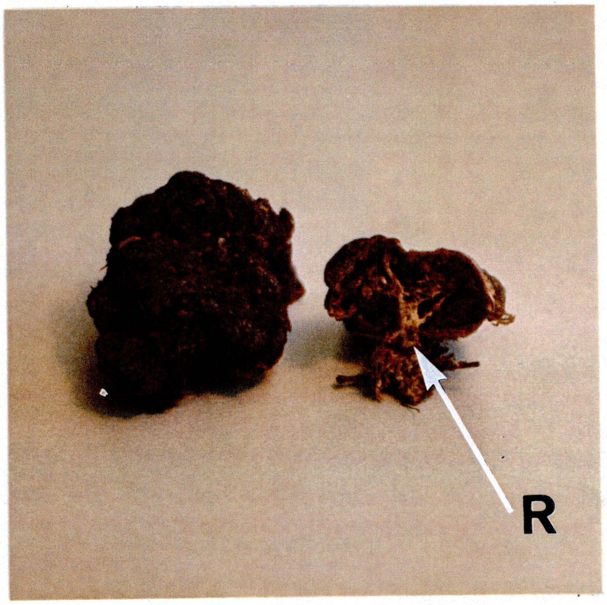

Figure 3.--Mature R. undulata ascocarp with a cross section showing the rhizoids (R) growing from the lower surface. July 1973

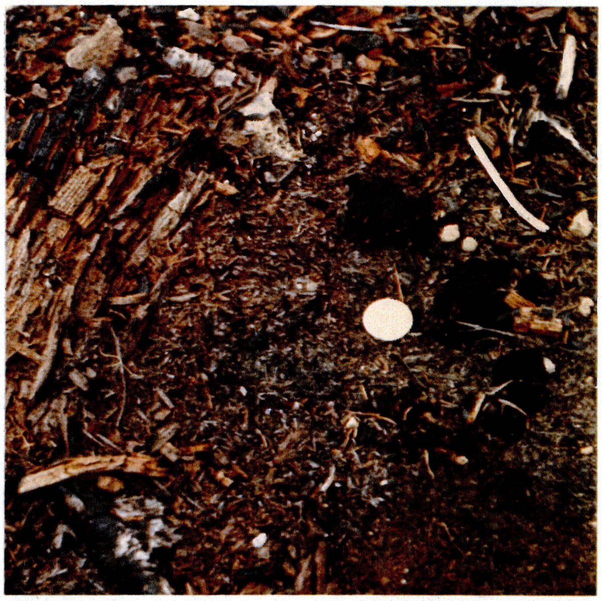

Figure 4.--Old ascocarps, resembling pieces of burned bark. August 1973

relatively thin with the margins in contact with the soil or duff. The center of the ascocarp may be supported an inch above the duff by root-like structures (rhizoids) growing from the lower surface (Figure 3). The rhizoids are white to yellow strands of hyphae which connect the ascocarp to woody debris or other food sources. Old ascocarps are nearly black resembling the burned duff and bark found in the immediate area (Figure 4). Depending on the activity of other microorganisms, the ascocarps may persist until frozen in the fall.

The reports by Morgan and Driver, plus a lack of accurate information on the distribution of R. undulata and the amount of damage it may be causing, were the impetus for this survey to determine if Rhizina root rot is a serious problem on National Forests in western Oregon and Washington.

## METHODS

Information concerning recent cutting units that had been burned and planted in western Oregon and Washington National Forests was provided by the Ranger Districts. This information was used to select units based on the following priority:

| Priority | Season of Burning |
|---|---|
| 1 | Spring 1972 |
| 2 | Fall 1971 |
| 3 | Fall 1972 |
| 4 | Spring 1971 |
| 5 | Fall 1970 |
| 6 | Spring 1970 |
| 7 | Fall 1969 |

The number of units selected on each District was proportional to the number of units submitted in priority classes one, two, and three. Top priority was given to broadcast burned units. When the list from a District contained only piled and burned units, at least one such unit was examined on that District. Survey units and alternate units were selected before the ground survey began, and without knowledge of the presence of the fungus or the success of the plantings. The designated alternate units on each District were to be used in the event the survey units could not be surveyed. The Districts provided sale area maps and additional valuable information for each of the units selected for the survey.

A two-stage survey procedure was used employing first a reconnaissance survey and then, when R. undulata ascocarps were found, a systematic survey.

A reconnaissance survey was done on each of the 144 units surveyed. The surveyors walked randomly over each unit searching for the ascocarps.

While the surveyors took additional time in areas of extreme topography, or other adverse conditions, the following minimum search times were established:

| Unit Size | Time Spent |
|---|---|
| Under 15 acres | 1 hour |
| Between 15 and 40 acres | 1-1/2 hours |
| Over 40 acres | 2 hours |

If the surveyors did not locate any ascocarps in the specified amount of time, the unit was classified as "Rhizina-not-found" and the survey moved on to the next unit. When ascocarps were found, the unit was classified as "Rhizina-found," the reconnaissance survey was stopped, and a systematic survey of the unit began.

The systematic survey of each unit was conducted by a pair of surveyors who examined approximately 5 percent of the area of each unit. Parallel transects, 6 chains apart with the first transect located 1-1/2 chains from an edge of the unit, were laid out and run the entire length of the unit. To conduct the survey, one surveyor paced the distance along the transect line while the second surveyor walked parallel to the transect but at least 10 feet from it. Each surveyor observed a survey strip 9.9 feet wide and kept tally of the dead trees observed within the strip. Each dead seedling was examined, classified, and recorded as either "Rhizina-killed" if a R. undulata ascocarp was found within 2 feet of the seedling, or "Other-killed." Every 5 chains along the transect a 1/20-acre circular plot (radius 26.3 feet) was established. The surveyors counted and recorded on a data sheet (Fig. 5 in Appendix) the total seedlings, Rhizina-killed seedlings and Other-killed seedlings within each plot. Additionally, the surveyors noted plots that contained R. undulata ascocarps and recorded other observations concerning the unit that seemed appropriate (e.g., completeness of burn or unusual topography). The purpose of the transects was to sample the area and cover the diverse site conditions on each unit so that the percentage of the mortality due to R. undulata could be defined. The plots were established to obtain unit stocking data and to define the frequency of appearance of R. undulata ascocarps.

## RESULTS

The results and observations listed below represent a compilation of the data from this survey (summer 1973):

### Unit Data

1. 165 units were inspected during the survey (Figure 6 and Table 1 in Appendix). The units were distributed on 46 Ranger Districts of 10 National Forests from the Oregon-California border to the Washington-Canadian border. Of the 165 units inspected, 21 had only the landings burned. Since these 21 units were not burned over their entire area, they were dropped from further considerations.

2. 144 units that met the survey criteria were surveyed - 85 were in Oregon and 59 were in Washington.

3. 23 units (16 percent of the units surveyed) were classified as Rhizina-found units - 8 were in Oregon and 15 were in Washington.

4. 29 units of those examined had been piled and burned.

5. 1 unit (3 percent) that had been piled and burned was classified as Rhizina-found.

6. The total area in the 144 units surveyed was 5,130 acres.

7. The total area in the Rhizina-found units was 756 acres.

8. The average size of the units surveyed (144) was 35.6 acres.

9. The average size of the Rhizina-found units (23) was 32.9 acres.

10. The average stocking density, based on the 1/20-acre plots, was 189.5 seedings/acre.

## Plot Data

1. 241 1/20-acre plots were established on Rhizina-found units.

2. 31 1/20-acre plots (12.9 percent) were classified as Rhizina-found plots.

3. The total area examined as 1/20-acre plots was 12 acres.

4. 2,284 seedlings were present on the 1/20-acre plots - 1,829 seedlings were on Rhizina-not-found plots and 455 seedlings were on Rhizina-found plots.

5. 9 Rhizina-killed seedlings were found on the 241 1/20-acre plots.

6. 0.75 Rhizina-killed seedlings/acre were the average within the 1/20-acre plots.

7. 0.4 percent of the seedlings found on the plots were Rhizina-killed.

8. 494 Other-killed seedlings were found on the 241 1/20 acre plots.

9. 21.5 percent of the seedlings on the plots were killed by other causes.

10. 503 dead seedlings were found on the 241 1/20-acre plots: 109 seedlings were on Rhizina-found plots and 394 seedlings were found on Rhizina-not-found plots.

## Transect Data

1. 1,276 chains of transect strips were examined on Rhizina-found units.

2. 38.3 acres were examined within the transect strips.

3. 5.1 percent of the area in the Rhizina-found units were examined as transect strips.

4. 20.1 percent of the seedlings found within the transect strips were dead.

5. 10 Rhizina-killed seedlings were found on the transect strips.

6. 0.26 Rhizina-killed seedling/acre was the average within the transect strips.

7. 0.13 percent of the seedlings found within the transect strips were Rhizina-killed.

8. 0.04 Rhizina-killed seedling/acre was the average for the 144 units surveyed.

9. 1,449 Other-killed seedlings were found within the transect strips.

10. 19.8 percent of the seedlings found within the transect strips were killed by other causes.

11. Distribution of units with respect to seedling mortality (transect data):

| Percent Seedling Mortality From All Causes | Number of Rhizina-Found Units |
|---|---|
| 0 - 5 | 8 |
| 6 - 25 | 6 |
| 26 - 50 | 5 |
| 51 - 75 | 4 |
| 76 - 100 | 0 |

## Statistical Treatment of Data

1. An analysis of the association between frequency of R. undulata ascocarps and overall seedling mortality on units was performed. The percentage of Rhizina-found plots on a unit was taken as the frequency of appearance of R. undulata on the unit. The seedling mortality data from the transects were used for the unit mortality data. A near zero correlation (r = .000089) was found when the percent Rhizina-found plots were compared to the percent overall seedling mortality.

2. An analysis was performed to compare the mortality recorded on Rhizina-found plots with the mortality recorded on the units. Of the 23 Rhizina-found units, 14 contained Rhizina-found plots. It was found that on Rhizina-found units the percent mortality in Rhizina-found plots and the percent mortality on the units were not significantly different (t = 0.953, n = 14) at the 95 percent confidence level. A strong correlation (r = .797) was found when the percent seedling mortality on the units was compared to the percent seedling mortality in Rhizina-found plots.

3. An analysis was performed to compare the mortality recorded for Rhizina-found plots with the mortality recorded for Rhizina-not-found. It was found that 12 of the units had at least two plots in each of the two classes. The percent mortality was calculated for each of the two classes of plots on each of the 12 units. This data was used in a t-test for paired plots. It was found that the percent mortality in Rhizina-found plots and Rhizina-not-found plots were not significantly different (t = 1.285, n = 12) at the 95 percent level. A strong correlation (r = .614) was found within units between average mortality in Rhizina-found plots and the average mortality in Rhizina-not-found plots.

## Other Relationships

1. Distribution of units with respect to aspect and elevation:

| | ASPECT* | | | |
|---|---|---|---|---|
| | N | S | E | W |
| Units surveyed | 58 | 63 | 59 | 71 |
| Percentage of total units surveyed | 23% | 25% | 23% | 28% |
| Rhizina-found units | 5 | 13 | 7 | 7 |
| Percentage of total from that aspect | 9% | 20% | 12% | 10% |
| Elevation range of units | 800-3200 | 800-4000 | 2000-4000 | 1600-4500 |
| Elevation average | 1920 | 2285 | 2957 | 2971 |

*A unit with an aspect of NW was recorded as both N and W. A flat unit was not assigned an aspect.

2. Distribution of plots with respect to aspect:

| | ASPECT | | | |
|---|---|---|---|---|
| | N | S | E | W |
| Total plots in Rhizina-found units | 76 | 131 | 82 | 84 |
| Rhizina-found plots | 15 | 15 | 9 | 9 |
| Percentage Rhizina-found plots | 20% | 11% | 11% | 11% |

3. Distribution of ascocarps with respect to slope position as indicated by Rhizina-found plots.

| | SLOPE POSITION* | | | |
|---|---|---|---|---|
| | Upper 1/3 | Middle 1/3 | Lower 1/3 | Flat |
| Number of units | 15 | 14 | 8 | 5 |

*A unit was classified by each slope position on which ascocarps were found.

4. Frequency of Rhizina-found plots with respect to areas in western Washington and Oregon (see map in Appendix):

| | AREA | | | |
|---|---|---|---|---|
| | N. Wash. | S. Wash. | N. Ore. | S. Ore. |
| Rhizina-found units | 12 | 3 | 8 | 0 |
| Total plots on Rhizina-found units | 152 | 29 | 60 | 0 |
| Rhizina-found plots | 12 | 7 | 12 | 0 |
| Percentage of Rhizina-found plots | 8% | 24% | 20% | 0 |
| Elevation range | 800-4500 | 2200-3800 | 800-4000 | --- |

5. Distribution of Rhizina-killed seedlings with respect to areas in western Washington and Oregon:

| | AREA | | | |
|---|---|---|---|---|
| | N. Wash. | S. Wash. | N. Ore. | S. Ore. |
| Rhizina-killed (plot data) | 7 | 2 | 0 | 0 |
| Rhizina-killed (transect data) | 3 | 5 | 2 | 0 |

6. Frequency of Rhizina-found units with respect to season burned:

| | SEASON OF BURN | | | | | | |
|---|---|---|---|---|---|---|---|
| | F69 | S70 | F70 | S71 | F71 | S72 | F72 |
| Units surveyed | 3 | 0 | 4 | 7 | 56 | 24 | 50 |
| Rhizina-found units | 0 | 0 | 0 | 1 | 11 | 5 | 6 |
| Percentage Rhizina-found units | 0 | 0 | 0 | 14 | 20 | 21 | 12 |

7. Mortality from all causes in Rhizina-found units with respect to time between burn and planting:

| | MONTHS BETWEEN BURN AND PLANTING | | | |
|---|---|---|---|---|
| | 18 | 12 | 6 | Under 6 |
| Units surveyed | 1 | 8 | 10 | 4 |
| Percentage mortality | 13% | 16% | 20% | 37% |

8. Generalized observations by the surveyors concerning all units inspected:

A. More _R_. _undulata_ ascocarps were observed on north or south facing slops than were observed on east or west facing slopes.

B. There appears to be a definite vegetation type associated with sites on which _R_. _undulata_ ascocarps were found. While notes on the general vegetation types were not made, mosses and liverworts were frequently observed on units where _R_. _undulata_ ascocarps were found.

C. Soil moisture and temperature appear to be important site factors in the formation of _R_. _undulata_ ascocarps. The ascocarps were found in moist well-drained areas, but never on or near the banks of flowing streams or in muddy areas.

D. Ascocarps of _R_. _undulata_ were found more frequently on units where the fire was hot enough to burn most of the duff than on units that were only lightly burned. More ascocarps were found on units where the large fuels were charred to a depth of one-fourth inch to one-half inch than on units where the fuels were charred to a depth of less than one-eighth inch.

E. Ascocarps were associated with buried woody debris.

F. The ascocarps appear to develop in protected or shaded areas such as near large stumps or under large logs.

G. The ascocarps were quite durable and were recognizable during much of the growing season. Easily observed and identifiable ascocarps were located within 2 weeks of snowmelt. Late in August many of the ascocarps appeared quite dark (black) and crusty but were still easily identifiable. The dark ascocarps were occasionally difficult to spot in areas of burned duff where pieces of bark were scattered about. Even during late August it was possible to find a young actively growing ascocarp or an actively growing margin on a dark crusty ascocarp.

H. On several occasions *R. undulata* ascocarps were observed well within the 2-foot "association distance" of seedlings that appeared healthy. Approximately five such occurrences were observed on the plots.

I. The ascocarps occasionally appeared as an isolated individual or a few individuals by a single stump. The usual occurrence pattern was as scattered ascocarps in large patches with a minimum size of 6 feet in diameter.

J. In areas that have been piled and burned, the ascocarps generally do not develop.

## DISCUSSION

This survey has provided previously unreported information on both the amount and the distribution of the damage attributable to *Rhizina undulata* Fr. on the National Forests of western Washington and Oregon. In addition, the survey has provided an insight to some site requirements of the organism.

While a total of 165 units were inspected, a reconnaissance survey was done on only 144 of the units. A total of 21 units were found to have been burned only at the landings. The burned landings, although small in area, were examined carefully for the presence of *R. undulata* ascocarps and none were found. Because *R. undulata* will only grow and produce ascocarps on areas that have been burned, and because the landings represent such a small proportion of the total area of the units, the 21 units were not further considered in analyzing the data.

The mortality data from this survey indicate that Rhizina root rot is not a serious problem on the National Forests of western Washington and Oregon at this time. The mortality attributed to Rhizina root rot was calculated to be an average of 0.04 seedlings per acre for the 144 units surveyed. Although *R. undulata* would probably not appear in the absence of fire, the mortality attributable to this organism is so small that a change in the current slash burning practices is not warranted.

Due to the lack of established criteria for identifying a Rhizina-killed seedling, assessing the significance of mortality data for Rhizina root rot is a complex problem. As yet, no easy clearcut method has been reported to positively identify Rhizina-killed seedlings in either the field or the laboratory. The best diagnostic system available is the association of R. undulata ascocarps with dead or dying seedlings. For this survey, dead or dying seedlings located within 2 feet of a R. undulata ascocarp were recorded as Rhizina-killed. The 2-foot association distance was selected as a loose consensus of interested investigators. The 2-foot distance has not been established by experimentation but, like much of the pathogenicity evidence for R. undulata, is rooted in historical field observations and the association of dead and dying seedlings with the ascocarps.

Data from the transects indicate that the mortality from all causes was 20.1 percent of the 23 Rhizina-found units. This loss of seedlings is not considered abnormally high for plantings in the Pacific Northwest Region, especially considering the very dry 1973 growing season. The 1972-73 winter snow cover was very light with early runoff. This was followed by a dry spring and summer that probably put the seedlings under unusual stress. Thus, it does not appear that the presence of R. undulata is associated with unusually high seedling mortality in the units.

Analysis of the data reflecting association between R. undulata ascocarps and dead seedlings supports the conclusion that the small loss attributed to Rhizina root rot by this survey is appropriate. A near zero correlation was found when the frequency of R. undulata ascocarps on units was compared to percent overall seedling mortality in those units. This indicates that R. undulata had little influence on the overall mortality on a unit. A strong correlation (r = .797) was found when seedling mortality on a unit was compared to the seedling mortality on Rhizina-found plots on that unit. A strong correlation (r = .614) was also found within units between the average mortality on Rhizina-found plots and the average mortality on Rhizina-not-found plots.

These analyses show that the mortality on the Rhizina-found plots paralleled both the mortality on Rhizina-not-found plots and the general mortality on the units. This is interpreted to mean that the presence of R. undulata, as indicated by ascocarps, has little, if any, effect on seedling mortality. For this reason the 2-foot association distance seems appropriate. Data collected during this survey do not support a larger association distance.

Observations of individual seedlings indicate some question regarding the association of R. undulata and seedling mortality. Since the surveyors found several seemingly healthy seedlings within the 2-foot association distance, it could be that the 19 Rhizina-killed seedlings recorded during the systematic survey represent a random association and not a cause and effect association. The low number of either live seedlings or dead seedlings observed within the 2-foot association distance during this survey does not provide sufficient evidence on which to base conclusions concerning the pathogenicity of R. undulata.

More seedlings would have been recorded as Rhizina-killed if a larger association distance had been used; however, such an increase would not have been justified or revealed an accurate assessment of the loss due to R. undulata. Since a definite correlation between the presence of R. undulata ascocarps and seedling mortality could not be shown for the units, plots, or individual seedlings, a larger number of recorded Rhizina-killed seedlings resulting from an arbitrarily larger association distance would have been meaningless and misleading.

In addition to data on the seedling mortality attributable to R. undulata, data were collected on the site requirements of the ascocarps. The units visited were distributed from the Washington-Canadian border south to the Oregon-California border. Rhizina-found units were located from the Baker River District in northern Washington to the Rigdon District in central Oregon. The attached map indicates the location of the units visited.

A total of 31 plots on 23 units were found to have ascocarps of R. undulata present. Examining a particular relationship by classifying the 23 units or 31 plots into many different classes results in groups too small to be meaningful. Several tables have been provided in the results section of this report purely for the readers interest and in the hope that the results of future surveys when added to present information will suggested a useful trend:

Most likely aspect - A larger percentage of Rhizina-found units were located on south slopes than any other aspect, while a larger percentage of Rhizina-found plots were located on north slopes than any other aspect. The recorded data is reinforced by the observation of the surveyors that they found more ascocarps on the north or south slopes.

Most likely time since burn - The survey indicated that R. undulata ascocarps were more likely to be found on units burned 12 or 18 months before the survey than on units burned 6 or 24 months before the survey.

Most likely elevation - The survey indicated that the ascocarps of R. undulata are more likely to appear at lower elevations on north or south slopes than on east or west slopes. The data on elevation is so inconclusive that no firm statement can be made. Even the lower elevational limit of 800 feet is not conclusive since only three units below that elevation were surveyed.

Soil conditions - Temperature and moisture seem to be the key site factors influencing production of ascocarps. High soil temperature seemed to be associated with the development of the ascocarps. This observation seems to be reinforced by the association of the ascocarps with blackened duff or soil surface and by the association of the ascocarps with south facing units. For the ascocarps to develop, the area must be moist but not wet. It is not possible to better quantify this observation. There are many indications of this relationship: (1) Liverworts and mosses were frequently associated with the ascocarps. (2) Soil in the vicinity of ascocarps was more moist than in the areas where the ascocarps were not found. (3) The ascocarps appeared to develop in protected or shaded areas such as around large stumps or under large logs. These areas were more moist than areas out in the open. (4) Soil moisture probably accounts for the greater frequency of the ascocarps on the upper one-third and middle one-third of the slopes as compared to the lower one-third or the flat areas. This relationship is supported both by plot data and by observations of the surveyors. The lower slope may, in many cases, have been too wet. (5) The ascocarps were not found in the vicinity of flowing streams or muddy areas. This suggests that there is an upper limit to the acceptable soil moisture for ascocarp development.

Intensity of Burn - A hot or complete burn appeared to be essential to the development of *R. undulata* ascocarps. *R. undulata* ascocarps were never located on a unit that was only lightly burned. The ascocarps were concentrated in areas where the large fuels had been completely burned or deeply charred. This observation fits with the pyrophilous needs of the ascospores. The charcoal and dust resulting from a hot fire would blacken the soil and cause a higher soil temperature during the growing season thus possibly encouraging the growth of *R. undulata*.

Proximity of woody debris - The consistent association of the ascocarps with buried woody debris was an observation of both the surveyors and past workers. On sites that had been piled and burned, the ascocarps were usually not found. This may be because the soil is disturbed and the piles burn very hot. Ascospores which are heated only enough to be activated may be too far from a food source to establish a colony. The woody debris is often in the form of large roots and buried pieces of logs. This observation helps to explain the frequent occurrence of the ascocarps around stumps on the burned areas.

The techniques used for this survey were designed to cover the largest number of units possible during one summer season. The reconnaissance survey was intended to quickly cover each unit searching the areas where the ascocarps were most likely to be found. The times set forth for the reconnaissance survey were minimum times with the surveyors searching each unit until they felt that it had been well covered. Even though the reconnaissance survey was done conscientiously, some units were probably recorded as Rhizina-not-found when in fact the fungus was present; however, any units incorrectly recorded as Rhizina-not-found probably had a very low population of ascocarps present. The systematic survey data are felt to provide a high degree of reliability. The systematic surveys were all performed by pairs of surveyors. A transect line was walked by two people, each looking at a strip only 10 feet wide. Only a few of the units surveyed had enough vegetation present to make it difficult to observe the seedlings. By slowing their pace, the survey crews were able to adequately search each transect strip. To establish the circular plots, one member of the survey crew stood at plot center holding one end of a measuring tape while the other member of the crew walked the circumference of the plot holding the other end of the tape. Both crew members examined the plot carefully and recorded the seedlings and ascocarps observed.

An interesting correlation has been suggested by the survey that is unrelated to Rhizina root rot. It appears that better survival is achieved in a plantation if the planting is not done immediately after the area is burned. The data are not adequate to suggest a "best" time-after-burn for planting, but it is adequate to suggest that a real difference may exist and should be further investigated.

A word of caution is appropriate concerning conclusions drawn from the seedling mortality data and damage assessment. Examination and interpretation of the data from this survey leads to the conclusion that _R. undulata_ is not causing a problem in the National Forests of western Washington and Oregon; however, care must be exercised to insure that the information is not extrapolated too far. The ascocarps, and in many cases the dead seedlings, will not persist from one year to the next. Thus, special relationships may have existed in previous seasons which were not apparent during this survey. While Rhizina root rot is not now a problem in the areas covered by this survey, we have no information to indicate that it never has been a problem or never will be a problem. In another area, with conditions different than in the Pacific Northwest Region, Rhizina root rot may be causing a great deal of damage. Even within the Region it is possible that conditions may be such in small localized areas that Rhizina root rot is causing serious seedling mortality.

## CONCLUSION

_Rhizina undulata_ is responsible for a nearly imperceptible amount of seedling mortality in the National Forests of western Washington and Oregon at this time; therefore, control action is not warranted.

## EPILOGUE

As a follow-up to the Rhizina root rot survey, a total of 27 semipermanent plots have been established in three heavily infested units on the Quilcene Ranger District, Wind River Ranger District, and Waldport Ranger District. For each plot, a map was made showing the relative location of live seedlings, dead seedlings, _R. undulata_ ascocarps, and stumps. Notes were made on the species, height, and condition of each seedling in each plot. Within the plots, four apparently healthy seedlings were found to be within the 2-foot association distance from _R. undulata_ ascocarps: two of the seedlings had been planted in 1971 and two of the seedlings had been planted in 1972. A pictorial record was made of each of the four seedlings. Pictures were also taken of 16 apparently healthy seedlings within the plots.

During the 1973 growing season, surveys to detect and evaluate seedling mortality resulting from Rhizina root rot were conducted on State and private lands in Oregon by Larry C. Weir, Forest Pathologist, Oregon State Department of Forestry, and on State land in Washington by Kenelm Russell, Forest Pathologist, Washington State Department of Natural Resources. During the Oregon survey (see Table 2 for a list) 51 units covering 1,800 acres were examined without locating _R. undulata_ ascocarps. During the Washington survey, 83 units covering approximately 5,542 acres were examined. A total of 42 Rhizina-found units were identified and systematically surveyed. Approximately 0.5 percent of the trees were recorded as Rhizina-killed. The units inspected by the States are listed in Tables 2 and 3 in the Appendix.

Table 1.--Units inspected during the 1973 *Rhizina undulata* survey conducted by the U. S. Forest Service.

| Forest | District | Township | Range | Section | Acres | *Rhizina undulata* | |
|---|---|---|---|---|---|---|---|
| | | | | | | Found | Not Found |
| Mt. Baker | Glacier | 40 N. | 7 E. | 19 | 36 | | X |
| | Baker | 34 N. | 7 E. | 17 | 76 | | X |
| | | 34 N. | 7 E. | 25 | 57 | | X |
| | | 34 N. | 7 E. | 14 | 21 | | X |
| | Darrington | 33 N. | 9 E. | 32 | 42 | X | |
| | | 32 N. | 11 E. | 7/18 | 22 | X | |
| | | 31 N. | 10 E. | 2 | 31 | X | |
| | | 32 N. | 10 E. | 29 | 23 | X | |
| | | 33 N. | 9 E. | 9/16 | 22 | | X |
| | Monte-Cristo | 30 N. | 8/9 E. | 24/19 | 20 | | X |
| | | 30 N. | 8 E. | 19 | 34 | X | |
| Olympic | Soleduck | 30 N. | 11 W. | 15 | 40 | | X |
| | | 28 N. | 12 W. | 8 | 30 | | X |
| | | 30 N. | 10 W. | 10/15 | 20 | | X |
| | | 29 N. | 12 W. | 16 | 34 | | X |
| | | 28 N. | 12 W. | 8 | 55 | X | |
| | | 30 N. | 12 W. | 10 | 22 | X | |
| | | 29 N. | 10/11 W. | 19/25 | 29 | | X |
| | | 30 N. | 11 W. | 13/14 | 50 | X | |
| | Quilcene | 28 N. | 3 W. | 15 | 15 | X | |
| | Hoodsport | 24 N. | 4 W. | 5 | 8 | | X |
| | Quinault | 23 N. | 10 W. | 3 | 50 | | X |
| | | 23 N. | 10 W. | 36 | 28 | | X |
| | | 23 N. | 8 W. | 25 | 56 | | X |
| | Shelton | 22 N. | 6 W. | 32/33 | 10 | | X |
| | | 21 N. | 6 W. | 2/ 3 | 44 | | X |
| | | 22 N. | 5 W. | 29 | 22 | | X |
| | | 22 N. | 7 W. | 10/15 | 84 | | X |
| Snoqualmie | Skykomish | 26 N. | 12 E. | 21 | 26 | X | |
| | | 25 N. | 12 E. | 18 | 12 | X | |
| | | 28 N. | 11 E. | 25 | 23 | X | |
| | N. Bend | 21 N. | 11 E. | 30 | 42 | | X |
| | White River | 18 N. | 9 E. | 15/16 | 55 | | X |
| | | 19 N. | 10 E. | 18 | 48 | | X |
| | | 19 N. | 11 E. | 30 | 45 | | X |

| Forest | District | Township | Range | Section | Acres | Rhizina undulata | |
|---|---|---|---|---|---|---|---|
| | | | | | | Found | Not Found |
| Gifford Pinchot | Packwood | 14 N. | 10 E. | 13 | 41 | | X |
| | | 14 N. | 10 E. | 33 | 32 | | X |
| | | 13 N. | 8 E. | 12 | 28 | | X |
| | | 13 N. | 9 E. | 17 | 23 | | X |
| | | 13 N. | 9 E. | 19 | 35 | | X |
| | | 13 N. | 10 E. | 18 | 26 | | X |
| | | 13 N. | 10 E. | 31 | 25 | | X |
| | Randle | 11 N. | 7 E. | 3 | 34 | | X |
| | | 9 N. | 9 E. | 15 | 25 | | X |
| | | 10 N. | 7 E. | 33 | 29 | | X |
| | | 11 N. | 8 E. | 2 | 47 | | X |
| | | 11 N. | 8 E. | 1 | 31 | | X |
| | Mt. Adams | 6 N. | 9 E. | 26 | 47 | | X |
| | | 6 N. | 9 E. | 24 | 29 | | X |
| | | 7 N. | 9 E. | 6 | 20 | | X |
| | | 7 N. | 9 E. | 22 | 22 | | X |
| | | 7 N. | 9 E. | 4 | 30 | X | |
| | | 8 N. | 8 E. | 24 | 22 | | X |
| | St. Helens | 8 N. | 7 E. | 1 | 35 | | X |
| | | 8 N. | 7 E. | 1 | 42 | X | |
| | | 8 N. | 6 E. | 26/35 | 41 | | X |
| | | 9 N. | 6 E. | 30 | 17 | | X |
| | | 8 N. | 4 E. | 32 | 43 | | X |
| | Wind River | 5 N. | 7 E. | 35/36 | 79 | | X |
| | | 5 N. | 7 E. | 16 | 15 | X | |
| | | 6 N. | 7 E. | 18 | 52 | | X |
| Mt. Hood | Columbia Gorge | 1 S. | 6 E. | 22 | 12 | | X |
| | | 1 S. | 5 E. | 23 | 29 | | X |
| | Hood River | 1 S. | 10 E. | 2 | 15 | | X |
| | | 1 N. | 8 E. | 22 | 12 | | X |
| | | 1 S. | 8 E. | 12 | 22 | | X |
| | Zigzag | 2 S. | 6 E. | 3 | 4 | | X |
| | | 2 S. | 6 E. | 11 | 15 | | X |
| | | 4 S. | 7 E. | 3 | 29 | | X |
| | Barlow | 1 S. | 11 E. | 29 | 17 | | X |
| | | 4 S. | 10 E. | 23 | 20 | | X |
| | Bear Springs | 4 S. | 8 E. | 3 | 32 | | X |
| | | 5 S. | 8 E. | 2 | 13 | | X |
| | | 5 S. | 8 E. | 11 | 13 | | X |
| | | 3 S. | 9 E. | 35 | 29 | | X |
| | | 3 S. | 9 E. | 24 | 24 | | X |
| | | 3 S. | 9 E. | 2 | 37 | | X |

| Forest | District | Township | Range | Section | Acres | Rhizina undulata | |
|---|---|---|---|---|---|---|---|
| | | | | | | Found | Not Found |
| Mt. Hood | Estacada | 5 S. | 6 E. | 21 | 26 | | X |
| | Clackamas | 7 S. | 8½ E. | 1 | 17 | | X |
| | | 7 S. | 6 E. | 36 | 61 | | X |
| Willamette | Detroit | 9 S. | 7 E. | 22/23 | 29 | | X |
| | | 10 S. | 6 E. | 19/30 | 25 | | X |
| | | 11 S. | 6 E. | 18 | 26 | | X |
| | Sweet Home | 15 S. | 4 E. | 30 | 39 | | X |
| | | 14 S. | 4 E. | 29/32 | 26 | | X |
| | | 14 S. | 4 E. | 18 | 25 | | X |
| | McKenzie | 15 S. | 6 E. | 8 | 27 | X | |
| | | 15 S. | 6 E. | 9/10 | 41 | | X |
| | | 16 S. | 7 E. | 31 | 42 | | X |
| | Blue River | 15 S. | 5 E. | 6 | 23 | | X |
| | | 15 S. | 5 E. | 9 | 35 | | X |
| | Oakridge | 21 S. | 5 E. | 23 | 43 | | X |
| | | 21 S. | 5 E. | 3 | 17 | X | |
| | | 22 S. | 5 E. | 8 | 11 | X | |
| | Rigdon | 22 S. | 2 E. | 10 | 35 | | X |
| | | 25 S. | 4 E. | 5 | 56 | | X |
| | | 23 S. | 4 E. | 19 | 29 | X | |
| Siuslaw | Hebo | 3 S. | 10 W. | 22 | 113 | X | |
| | | 3 S. | 10 W. | 9 | 34 | | X |
| | | 5 S. | 9 W. | 35 | 22 | | X |
| | | 5 S. | 9 W. | 7 | 18 | | X |
| | Waldport | 14 S. | 11 W. | 3 | 5 | | X |
| | | 16 S. | 11 W. | 33/34 | 20 | | X |
| | | 13 S. | 11 W. | 12 | 25 | | X |
| | | 14 S. | 10 W. | 15 | 65 | | X |
| | | 16/17 S. | 11 W. | 33/34 | 69 | X | |
| | | 13 S. | 10 W. | 20 | 18 | X | |
| | | 13 S. | 10 W. | 20 | 30 | X | |
| | Mapleton | 16 S. | 9 W. | 22 | 20 | | X |
| | | 16 S. | 9 W. | 20 | 74 | | X |
| | | 16 S. | 10 W. | 34 | 15 | | X |
| | | 16 S. | 10 W. | 8 | 4 | | X |
| | | 16 S. | 10 W. | 30 | 17 | | X |
| | | 16 S. | 9 W. | 1 | 17 | | X |
| | Smith River | 22 S. | 10 W. | 5 | 50 | | X |
| | | 19 S. | 10 W. | 24 | 18 | | X |
| | | 21 S. | 10 W. | 28 | 75 | | X |
| | | 19 S. | 10 W. | 27/28 | 117 | | X |
| | | 22 S. | 10 W. | 6 | 71 | | X |
| | | 20 S. | 10 W. | 6 | 63 | | X |

| | | | | | | Rhizina undulata | |
|---|---|---|---|---|---|---|---|
| Forest | District | Township | Range | Section | Acres | Found | Not Found |
| Umpqua | Steamboat | 25 S. | 1 E. | 19 | 38 | | X |
| | | 24 S. | 1 E. | 13 | 30 | | X |
| | Cottage Grove | 21 S. | 1 E. | 2 | 24 | | X |
| | | 21 S. | 1 E. | 1/2 | 12 | | X |
| | | 21 S. | 1 E. | 9 | 40 | | X |
| | | 21 S. | 1 E. | 2 | 14 | | X |
| | | 21 S. | 2 E. | 20 | 20 | | X |
| | | 22 S. | 1 E. | 33 | 43 | | X |
| | | 21 S. | 1 E. | 6 | 10 | | X |
| | | 22 S. | 2 E. | 1 | 15 | | X |
| | | 22 S. | 2 E. | 1 | 20 | | X |
| | Diamond Lake | 26 S. | 4 E. | 6 | 22 | | X |
| | | 27 S. | 5 E. | 6/7 | 11 | | X |
| | | 26 S. | 4 E. | 23 | 14 | | X |
| | | 28 S. | 3 E. | 11 | 21 | | X |
| | Glide | 27 S. | 1 E. | 8/9 | 24 | | X |
| | | 27 S. | 1 E. | 29 | 12 | | X |
| | | 28 S. | 2 E. | 8 | 47 | | X |
| | | 27 S. | 1 E. | 33 | 16 | | X |
| | Tiller | 28 S. | 1 E. | 29/32 | 36 | | X |
| | | 28 S. | 1 E. | 30 | 36 | | X |
| | | 30 S. | 2 E. | 10/11 | 57 | | X |
| | | 28 S. | 2 E. | 13 | 30 | | X |
| Rogue River | Prospect | 30 S. | 4 E. | 22/27 | 324 | | X |
| | | 30 S. | 4 E. | 20/29 | 75 | | X |
| | | 31 S. | 4 E. | 34 | 13 | | X |
| | Butte Falls | 34 S. | 3 E. | 9 | 6 | | X |
| | | 34 S. | 4 E. | 28 | 8 | | X |
| | | 34 S. | 4 E. | 20 | 70 | | X |
| Siskiyou | Powers | 32 S. | 12 W. | 10 | 28 | | X |
| | | 33 S. | 11 W. | 12 | 27 | | X |
| | | 33 S. | 14 W. | 32 | 17 | | X |
| | | 33 S. | 12 W. | 20 | 51 | | X |
| | | 33 S. | 12 W. | 20 | 38 | | X |
| | | 33 S. | 12 W. | 29/31/32 | 87 | | X |
| | Gold Beach | 35 S. | 10½ W. | 7 | 51 | | X |
| | | 34 S. | 12 W. | 23/24 | 66 | | X |
| | Chetco | 40 S. | 12 W. | 20 | 37 | | X |
| | | 41 S. | 11 W. | 6 | 41 | | X |
| | | 37 S. | 13 W. | 26/23 | 169 | | X |
| | | 38 S. | 12 W. | 20/21/28 | 90 | | X |

| | | | | | | Rhizina undulata | |
|---|---|---|---|---|---|---|---|
| Forest | District | Township | Range | Section | Acres | Found | Not Found |
| Siskiyou | Illinois Valley | 41 S. | 7 W. | 2 | 19 | | X |
| | | 40 S. | 5 W. | 6 | 17 | | X |
| | | 38 S. | 9 W. | 23 | 28 | | X |
| | | 18 N. | 6 E. | 7 | 46 | | X |

Table 2.--Units inspected during the 1973 *Rhizina undulata* survey conducted by the Oregon State Department of Forestry.

| | | | | *Rhizina undulata* | |
|---|---|---|---|---|---|
| County | Township | Range | Section | Found | Not Found |
| Benton | 14 S. | 7 W. | 23 | | X |
| | 14 S. | 7 W. | 26 | | X |
| | 14 S. | 7 W. | 34 | | X |
| Clackamas | 5 S. | 4 E. | 21 | | X |
| | 7 S. | 5 E. | 8 | | X |
| Columbia | 4 N. | 3 W. | 35 | | X |
| | 5 N. | 5 W. | 2 | | X |
| | 6 N. | 2 W. | 7 | | X |
| | 7 N. | 5 W. | 34 | | X |
| Coos | 23 S. | 10 W. | 20 | | X |
| Curry | 33 S. | 9 W. | 30 | | X |
| Douglas | 19 S. | 8 W. | 16 | | X |
| | 19 S. | 8 W. | 20 | | X |
| | 19 S. | 8 W. | 22 | | X |
| | 20 S. | 8 W. | 14 | | X |
| | 20 S. | 8 W. | 17 | | X |
| | 20 S. | 9 W. | 2 | | X |
| | 20 S. | 9 W. | 12 | | X |
| | 20 S. | 9 W. | 21 | | X |
| | 20 S. | 9 W. | 23 | | X |
| | 20 S. | 10 W. | 12 | | X |
| | 20 S. | 10 W. | 36 | | X |
| | 21 S. | 9 W. | 7 | | X |
| | 21 S. | 9 W. | 10 | | X |
| | 21 S. | 10 W. | 12 | | X |
| | 23 S. | 9 W. | 24 | | X |
| | 32 S. | 6 W. | 18 | | X |
| Jackson | 38 S. | 3 E. | 11 | | X |
| | 38 S. | 3 E. | 25 | | X |
| | 38 S. | 4 E. | 7 | | X |
| | 39 S. | 3 E. | 22 | | X |
| | 39 S. | 4 E. | 35 | | X |
| Josephine | 38 S. | 6 W. | 2 | | X |
| | 39 S. | 6 W. | 6 | | X |
| | 39 S. | 7 W. | 23 | | X |
| Lane | 15 S. | 7 W. | 17 | | X |
| | 16 S. | 2 E. | 1 | | X |
| | 18 S. | 6 W. | 20 | | X |
| | 19 S. | 1 W. | 35 | | X |
| | 19 S. | 7 W. | 4 | | X |

| County | Township | Range | Section | *Rhizina undulata* Found | *Rhizina undulata* Not Found |
|---|---|---|---|---|---|
| Lane | 21 S. | 1 W. | 9 |  | X |
|  | 22 S. | 2 W. | 11 |  | X |
| Lincoln | 11 S. | 9 W. | 24 |  | X |
|  | 11 S. | 10 W. | 21 |  | X |
| Tillamook | 4 S. | 7 W. | 15 |  | X |
|  | 4 S. | 7 W. | 16 |  | X |
| Yamhill | 2 S. | 6 W. | 17 |  | X |
|  | 3 S. | 5 W. | 6 |  | X |
|  | 3 S. | 5 W. | 19 |  | X |
|  | 3 S. | 6 W. | 5 |  | X |
|  | 4 S. | 7 W. | 22 |  | X |

Table 3.--Units inspected during the 1973 *Rhizina undulata* survey conducted by the Washington State Department of Natural Resources.

| County | Township | Range | Section | *Rhizina undulata* Found | *Rhizina undulata* Not Found |
|---|---|---|---|---|---|
| Clallam | 31 N. | 9 W. | 31 | X | |
| | 31 N. | 9 W. | 19/30 | | X |
| | 30 N. | 5 W. | 23 | | X |
| | 30 N. | 4 W. | 32/33 | | X |
| | 32 N. | 14 W. | 36 | | X |
| | 32 N. | 14 W. | 36 | | X |
| | 32 N. | 13 W. | 29 | | X |
| | 31 N. | 15 W. | 36 | X | |
| | 31 N. | 15 W. | 36 | X | |
| | 29 N. | 14 W. | 24 | | X |
| | 28 N. | 13 W. | 29 | X | |
| Clark | 6 N. | 3 E. | 36 | | X |
| | 6 N. | 4 E. | 28/33 | | X |
| Cowlitz | 10 N. | 2 W. | 18 | | X |
| | 6 N. | 2 E. | 35/36 | | X |
| | 7 N. | 1 E. | 20 | | X |
| | 10 N. | 3 E. | 36 | | X |
| | 6 N. | 2 E. | 22 | | X |
| | 7 N. | 1 W. | 6 | | X |
| Harbor | 17 N. | 5 W. | 10 | | X |
| Jefferson | 29 N. | 2 W. | 16 | X | |
| | 29 N. | 2 W. | 16 | X | |
| | 28 N. | 2 W. | 23 | X | |
| | 27 N. | 12 W. | 25 | X | |
| | 27 N. | 12 W. | 27 | X | |
| | 27 N. | 12 W. | 36 | X | |
| | 27 N. | 12 W. | 36 | X | |
| | 25 N. | 11 W. | 4 | X | |
| | 25 N. | 11 W. | 8 | X | |
| | 25 N. | 11 W. | 9 | X | |
| | 25 N. | 11 W. | 17 | X | |
| | 25 N. | 11 W. | 10/11 | X | |
| | 25 N. | 11 W. | 33 | X | |
| | 24 N. | 11 W. | 31 | X | |
| | 24 N. | 11 W. | 32 | X | |
| | 24 N. | 11 W. | 24 | X | |
| | 24 N. | 11 W. | 13/24 | X | |
| | 24 N. | 11 W. | 36 | X | |
| | 24 N. | 11 W. | 36 | X | |
| | 24 N. | 11 W. | 36 | X | |
| | 24 N. | 11 W. | 36 | X | |
| | 24 N. | 11 W. | 27 | X | |
| | 24 N. | 11 W. | 23 | X | |

| County | Township | Range | Section | *Rhizina undulata* | |
|---|---|---|---|---|---|
| | | | | Found | Not Found |
| King | 25 N. | 9 E. | 16 | X | |
| | 20 N. | 8 E. | 10 | | X |
| | 20 N. | 8 E. | 10 | | X |
| Kitsap | 25 N. | 1 W. | 25/26 | | X |
| | 25 N. | 1 W. | 26 | | X |
| | 25 N. | 1 W. | 26 | | X |
| | 25 N. | 1 W. | 26 | | X |
| | 24 N. | 1 W. | 19 | | X |
| | 24 N. | 1 W. | 14 | | X |
| | 24 N. | 1 W. | 17/18 | | X |
| Lewis | 13 N. | 4 W. | 2 | | X |
| | 14 N. | 3 W. | 7 | | X |
| | 12 N. | 3 W. | 25/26 | | X |
| Mason | 19 N. | 4 W. | 36 | | X |
| | 19 N. | 4 W. | 16 | | X |
| | 22 N. | 3 W. | 4 | X | |
| | 22 N./23 N. | 3 W./3 W. | 4/33 | X | |
| | 23 N. | 2 W. | 16/21 | X | |
| | 23 N. | 2 W. | 16/21 | X | |
| | 23 N. | 1 W. | 16 | | X |
| | 22 N. | 2 W. | 3/4/9 | | X |
| Pacific | 13 N. | 6 W. | 34/35 | | X |
| Pierce | 22 N. | 1 E. | 16 | | X |
| Skagit | 33 N. | 10 E. | 10 | | X |
| | 34 N. | 7 E. | 36 | | X |
| | 33 N. | 6 E. | 4/5 | | X |
| | 36 N. | 8 E. | 14 | X | |
| | 33 N. | 5/6 E. | 19/24 | X | |
| Skamania | 7 N. | 5 E. | 32 | | X |
| Snohomish | 32 N. | 6 E. | 23 | X | |
| | 30 N. | 7 E. | 5/8 | X | |
| | 27 N. | 8 E. | 20 | X | |
| | 27 N. | 7 E. | 25/36 | X | |
| Thurston | 15 N. | 2 W. | 5/8 | | X |
| Wahkiakum | 10 N. | 8 W. | 11 | X | |
| | 10 N. | 6 W. | 19 | X | |
| | 9 N. | 4 W./5 W. | 30/31/25 | | X |
| Whatco | 40 N. | 5 E. | 24 | X | |
| | 37 N. | 6 E. | 16 | | X |
| | 40 N. | 6 E. | 20 | X | |

Figure 5.--*Rhizina undulata* Survey field data sheet.

## *Rhizina undulata* Survey

Page ____ of ____

Forest ________________ District ____________ Unit No. __________

Date Burned ______________ Dates Planted ____________________

Species ________________ Survey Date ________ Crew ____________

Acreage __________ Length of Transect ________ % Survey __________

### Transects

Cause of Mortality

| No. | *R. undulata* | | | | Other | | | |
|---|---|---|---|---|---|---|---|---|
| | Species | | | | Species | | | |
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### Plots

Mortality

| No. | Total Seedlings | *R. undulata* Killed | | | | Other | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Species | | | | Species | | | |
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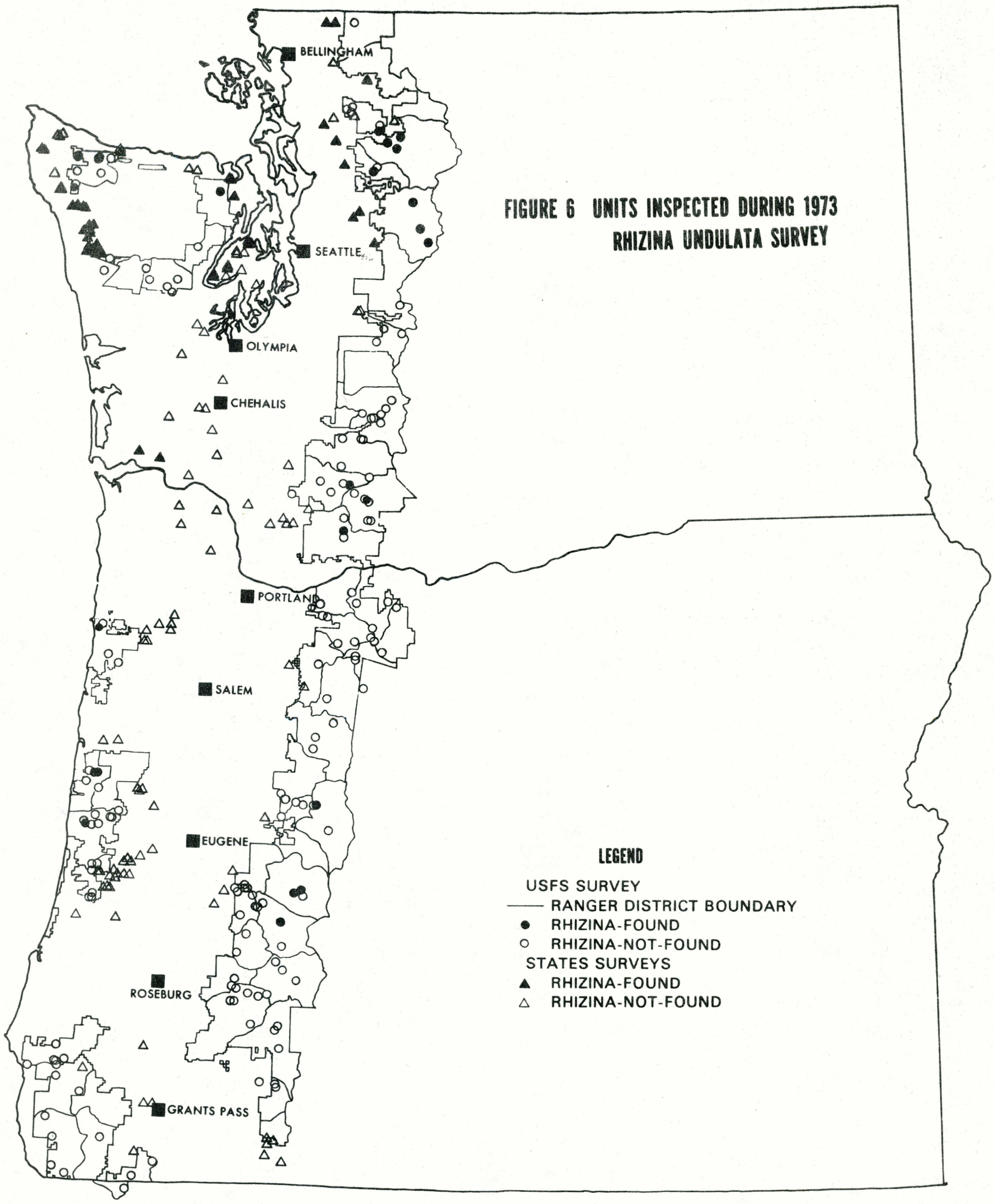

FIGURE 6 UNITS INSPECTED DURING 1973 RHIZINA UNDULATA SURVEY

BELLINGHAM
SEATTLE
OLYMPIA
CHEHALIS
PORTLAND
SALEM
EUGENE
ROSEBURG
GRANTS PASS
LEGEND
USFS SURVEY
RANGER DISTRICT BOUNDARY
● RHIZINA-FOUND
○ RHIZINA-NOT-FOUND
STATES SURVEYS
▲ RHIZINA-FOUND
△ RHIZINA-NOT-FOUND